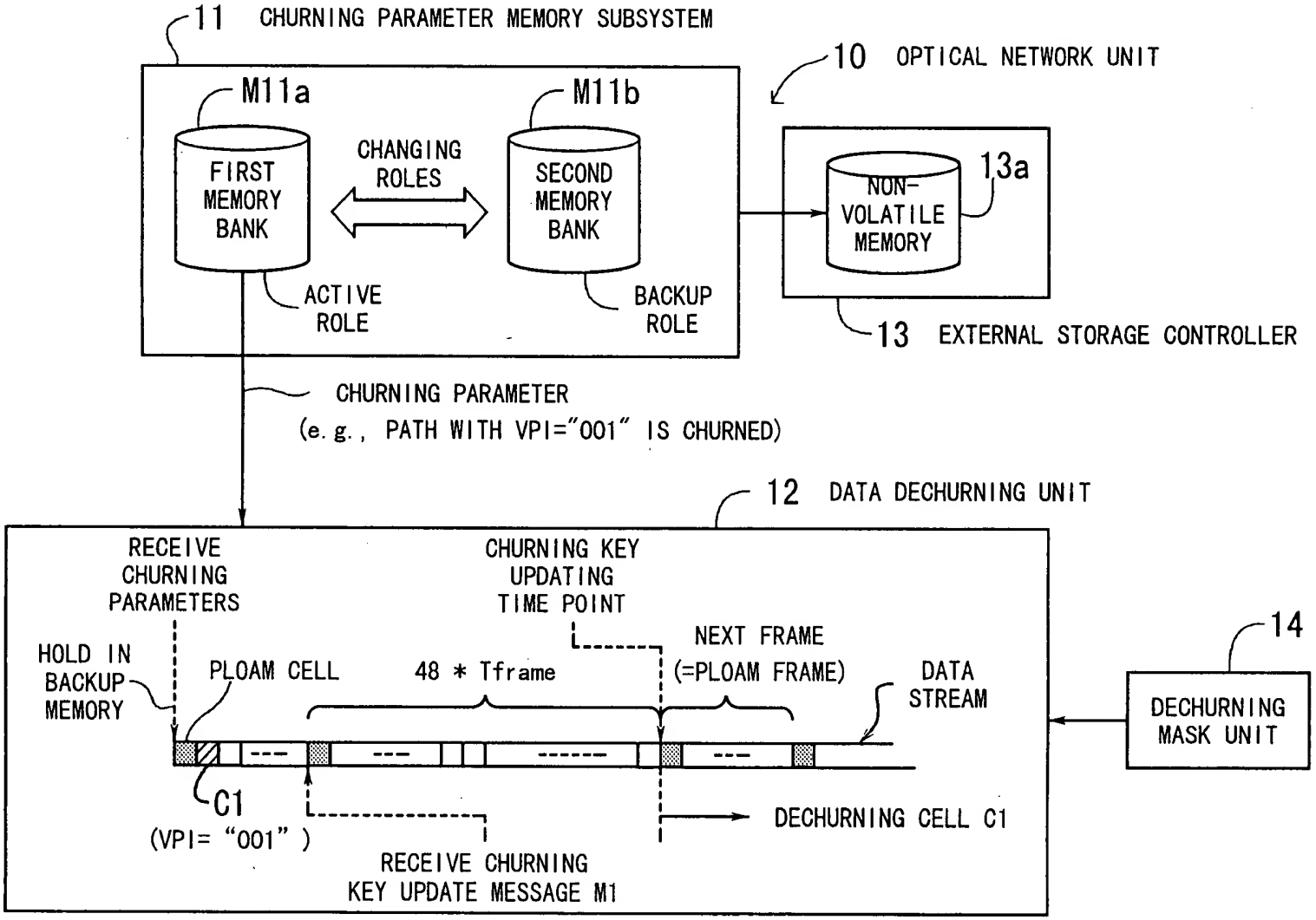
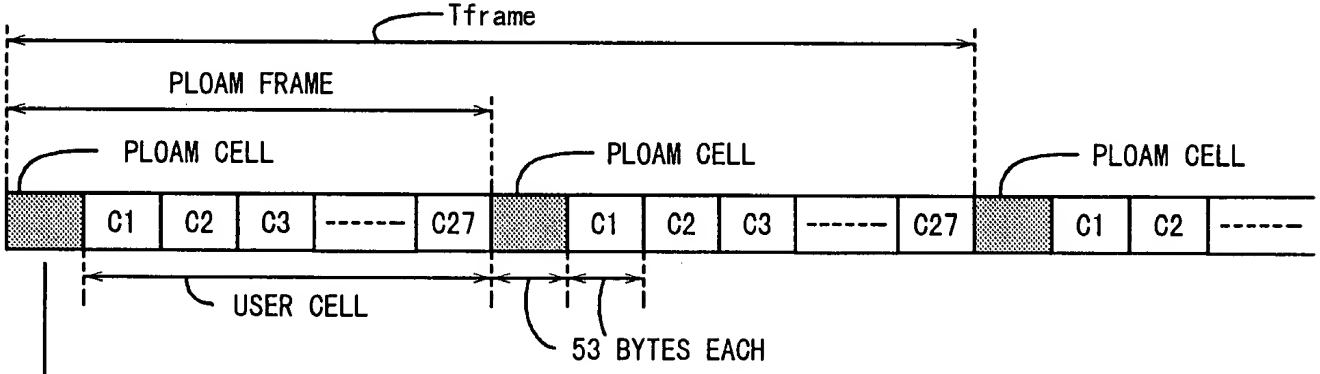

11 CHURNING PARAMETER MEMORY SUBSYSTEM
M11a
M11b
FIRST MEMORY BANK
CHANGING ROLES
SECOND MEMORY BANK
ACTIVE ROLE
BACKUP ROLE
10 OPTICAL NETWORK UNIT
NON-VOLATILE MEMORY
13a
13 EXTERNAL STORAGE CONTROLLER
CHURNING PARAMETER
(e.g., PATH WITH VPI="001" IS CHURNED)
12 DATA DECHURNING UNIT
RECEIVE CHURNING PARAMETERS
CHURNING KEY UPDATING TIME POINT
NEXT FRAME (=PLOAM FRAME)
HOLD IN BACKUP MEMORY
PLOAM CELL
48 * Tframe
DATA STREAM
14
DECHURNING MASK UNIT
C1
(VPI= "001")
DECHURNING CELL C1
RECEIVE CHURNING KEY UPDATE MESSAGE M1

FIG. 1

<DOWNSTREAM FRAME STRUCTURE>



CHURNED-VP PARAMETERS		
BYTE	CONTENT	DESCRIPTION
40	PON-ID	PON-ID OF ONU
41	"00001111"	MESSAGE IDENTIFICATION "CHURNED-VP"
42	"x x x x x x x a"	a=1 : Churned a=0 : Not Churned
43	"abcdefgh"	abcdefgh=VPI [11 : 4]
44	"ijkl0000"	ijkl=VPI [3 : 0]
45~51	"unspesified"	Don' t care

FIG. 2

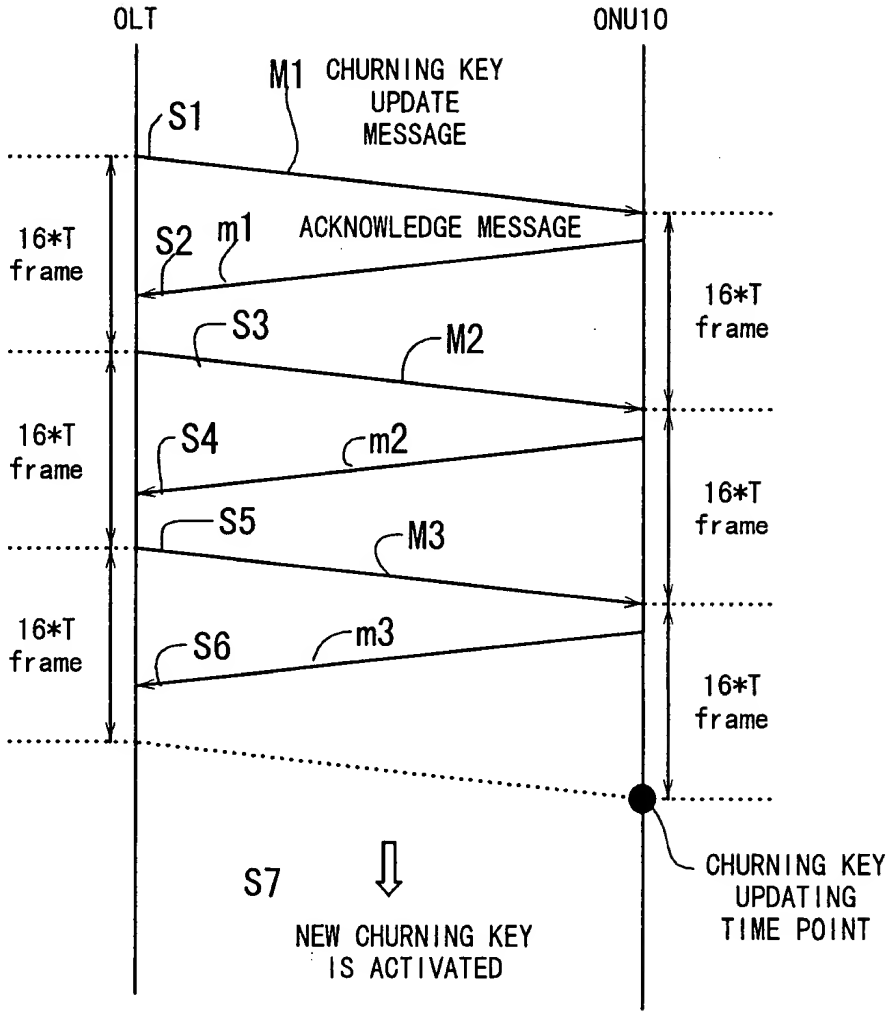

OLT
ONU10
M1 CHURNING KEY UPDATE MESSAGE
S1
16*T frame
S2
m1
ACKNOWLEDGE MESSAGE
S3
M2
S4
m2
S5
M3
S6
m3
S7
NEW CHURNING KEY IS ACTIVATED
CHURNING KEY UPDATING TIME POINT

FIG. 3

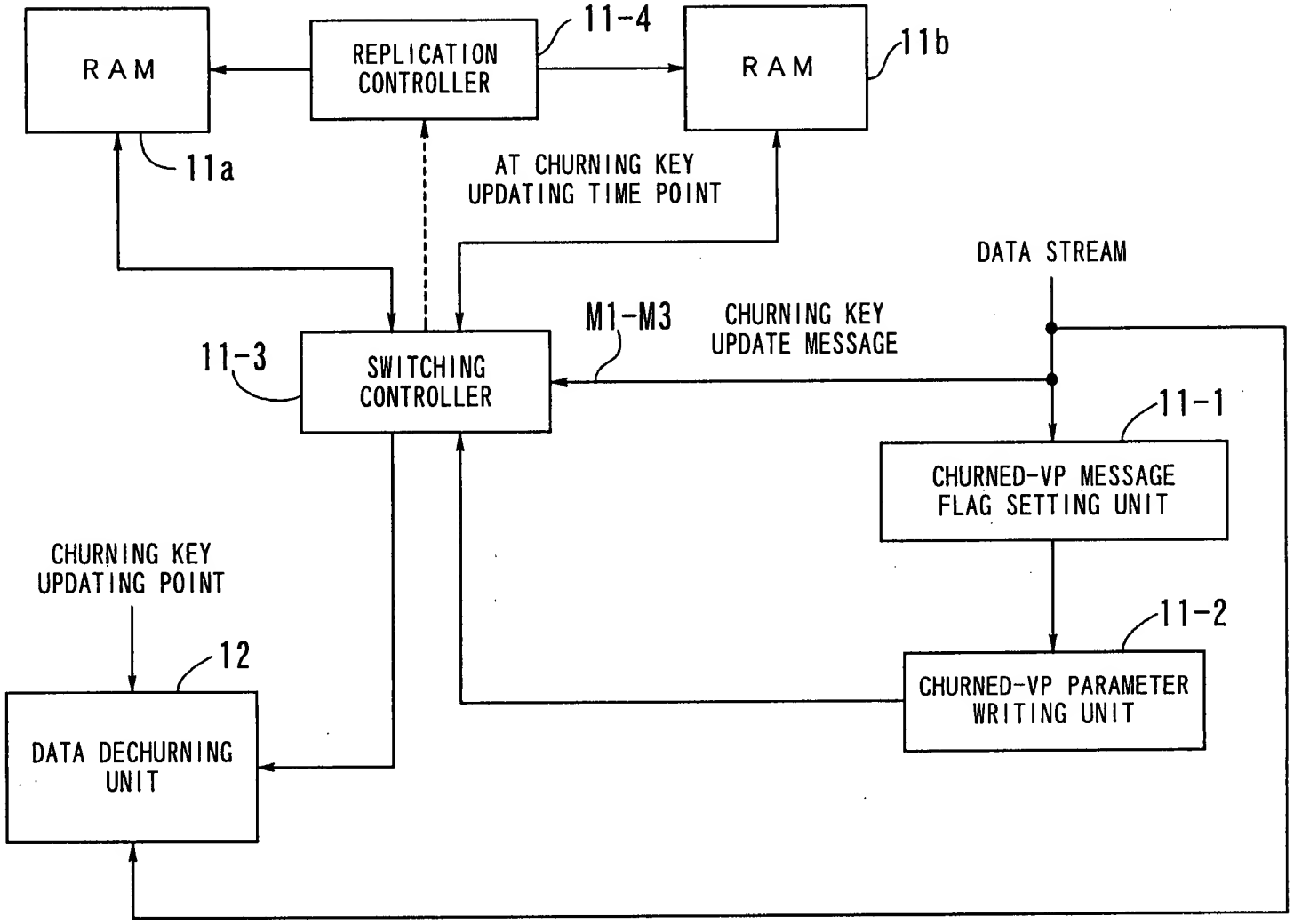

RAM
REPLICATION CONTROLLER
11-4
RAM
11b
11a
AT CHURNING KEY UPDATING TIME POINT
DATA STREAM
M1-M3
CHURNING KEY UPDATE MESSAGE
11-3
SWITCHING CONTROLLER
11-1
CHURNED-VP MESSAGE FLAG SETTING UNIT
CHURNING KEY UPDATING POINT
11-2
12
CHURNED-VP PARAMETER WRITING UNIT
DATA DECHURNING UNIT

FIG. 4

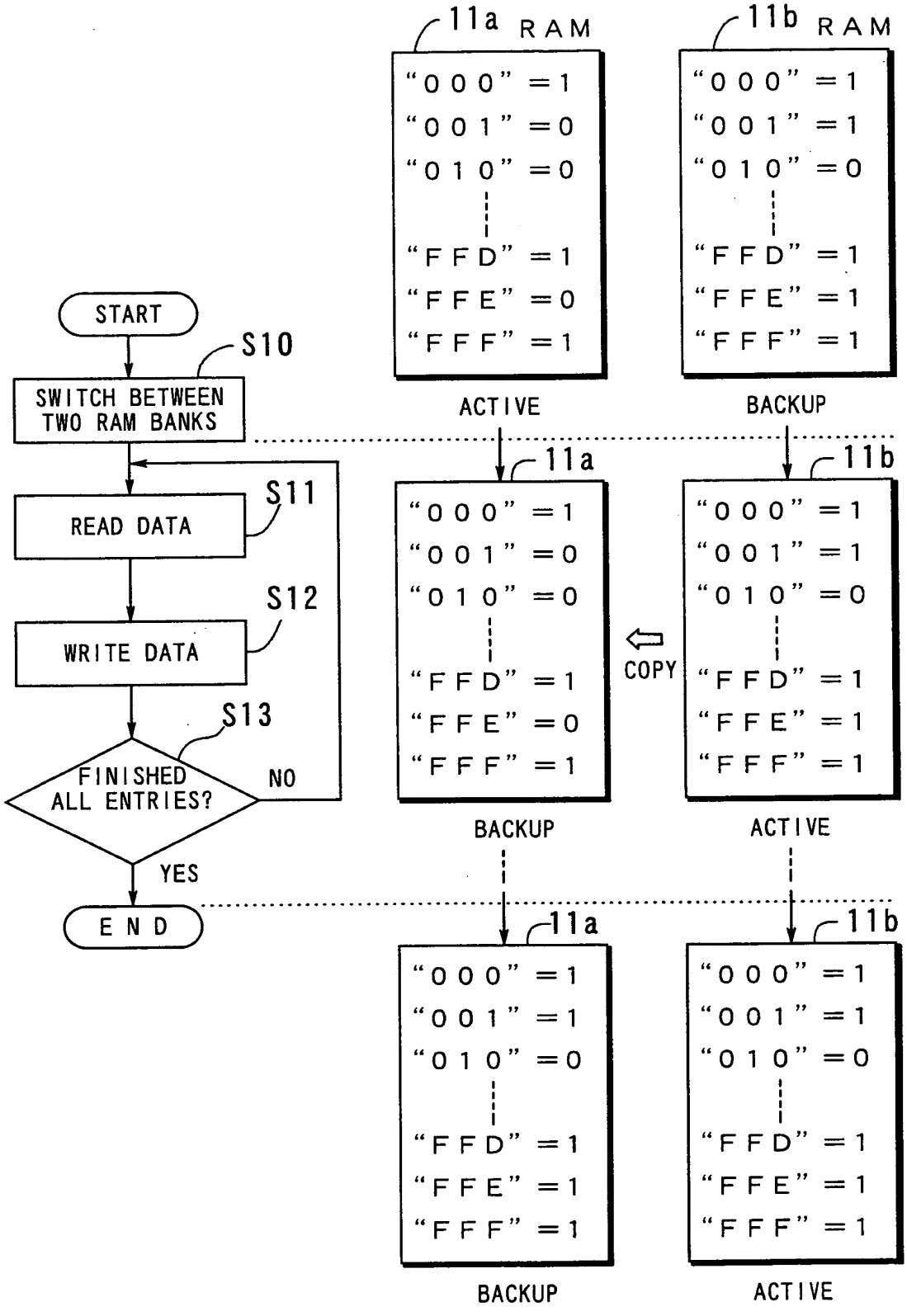

11a RAM
"000" =1
"001" =0
"010" =0
"FFD" =1
"FFE" =0
"FFF" =1
11b RAM
"000" =1
"001" =1
"010" =0
"FFD" =1
"FFE" =1
"FFF" =1
START
S10
SWITCH BETWEEN TWO RAM BANKS
ACTIVE
BACKUP
S11
READ DATA
S12
WRITE DATA
S13
FINISHED ALL ENTRIES?
NO
YES
END
11a
11b
COPY
BACKUP
ACTIVE
11a
11b
BACKUP
ACTIVE

FIG. 5

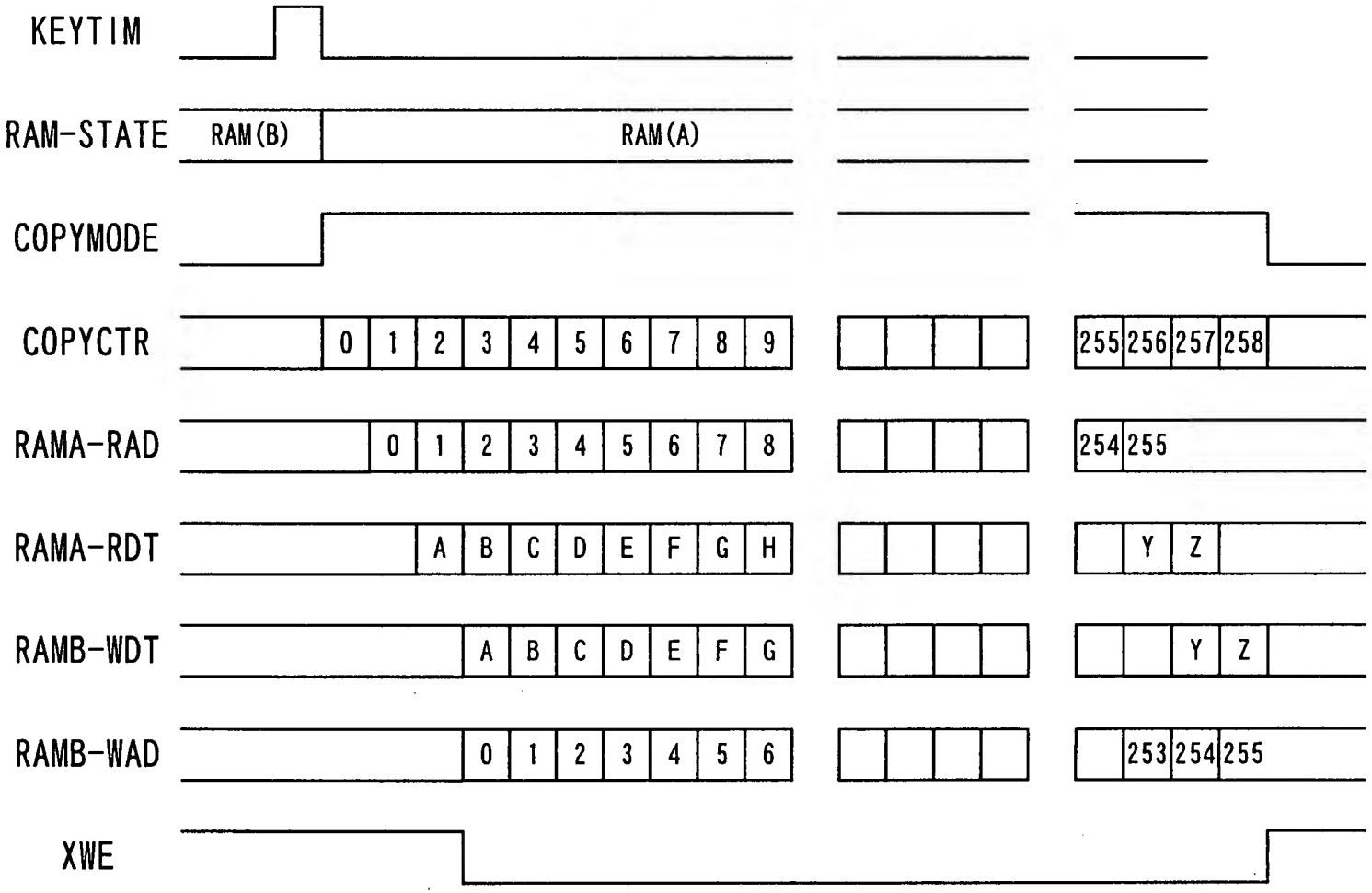

KEYTIM
RAM-STATE
RAM(B)
RAM(A)
COPYMODE
COPYCTR
0 1 2 3 4 5 6 7 8 9
255 256 257 258
RAMA-RAD
0 1 2 3 4 5 6 7 8
254 255
RAMA-RDT
A B C D E F G H
Y Z
RAMB-WDT
A B C D E F G
Y Z
RAMB-WAD
0 1 2 3 4 5 6
253 254 255
XWE

FIG. 6

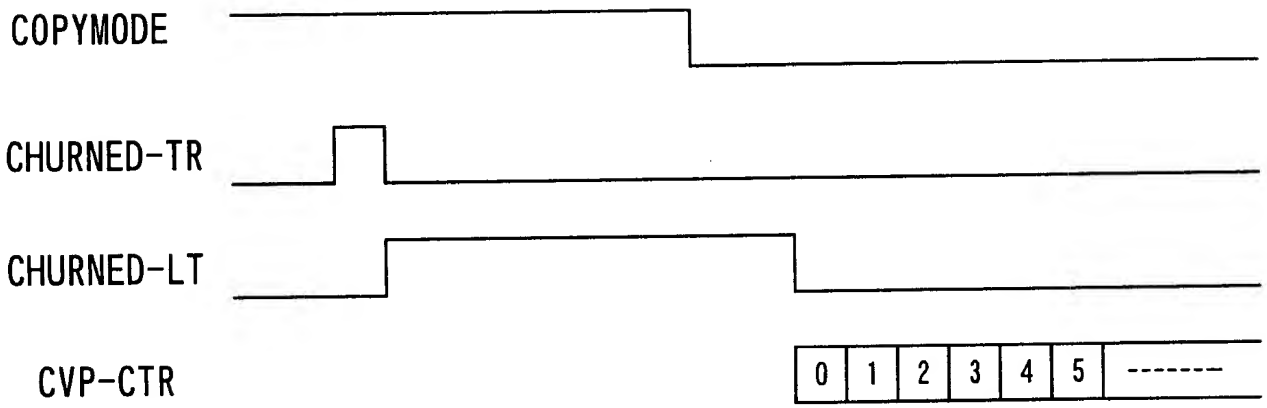


FIG. 7

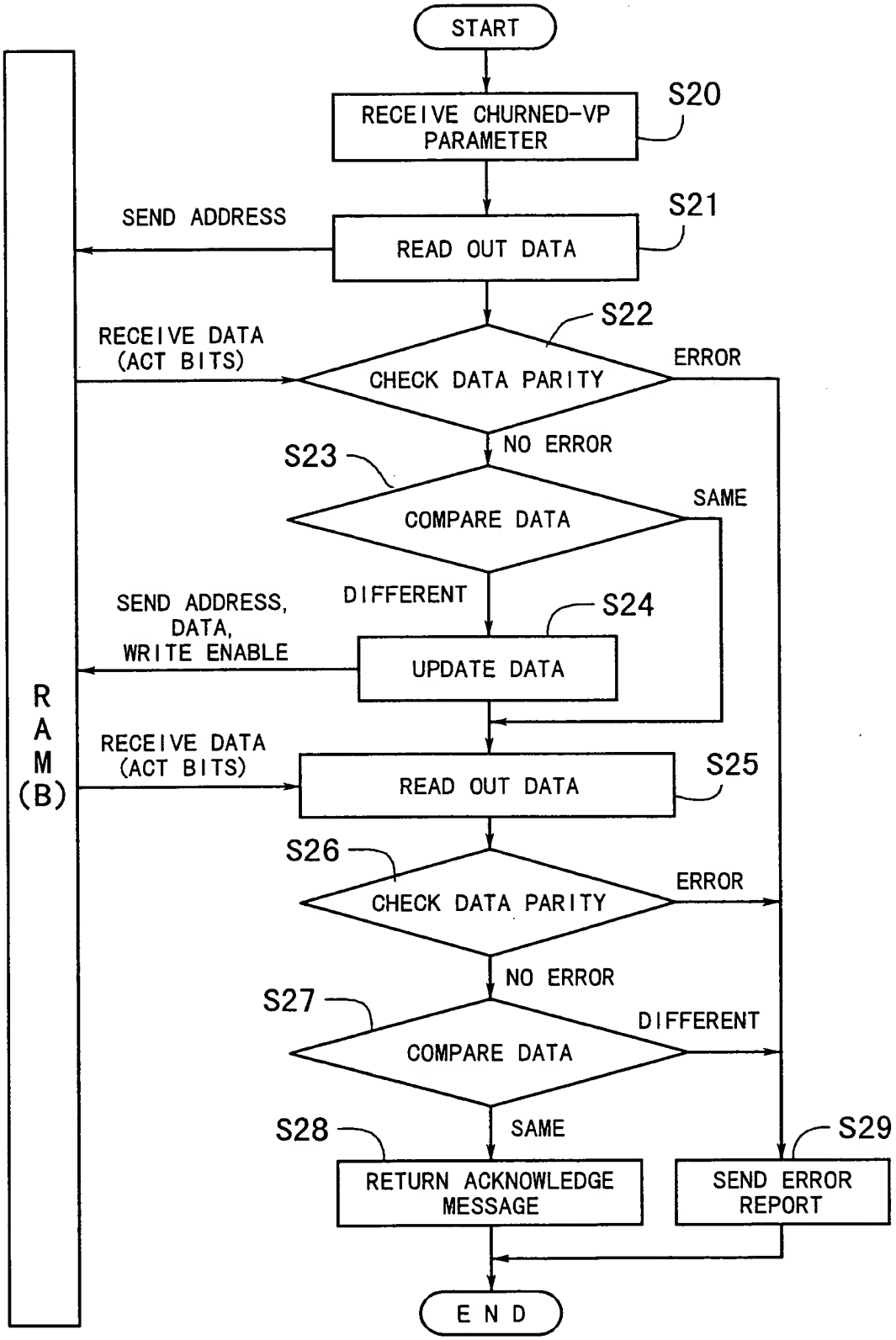

START
RECEIVE CHURNED-VP PARAMETER
S20
SEND ADDRESS
READ OUT DATA
S21
RECEIVE DATA (ACT BITS)
CHECK DATA PARITY
S22
ERROR
NO ERROR
S23
COMPARE DATA
SAME
DIFFERENT
SEND ADDRESS, DATA, WRITE ENABLE
UPDATE DATA
S24
RAM (B)
RECEIVE DATA (ACT BITS)
READ OUT DATA
S25
S26
CHECK DATA PARITY
ERROR
NO ERROR
S27
COMPARE DATA
DIFFERENT
SAME
S28
S29
RETURN ACKNOWLEDGE MESSAGE
SEND ERROR REPORT
END

FIG. 8

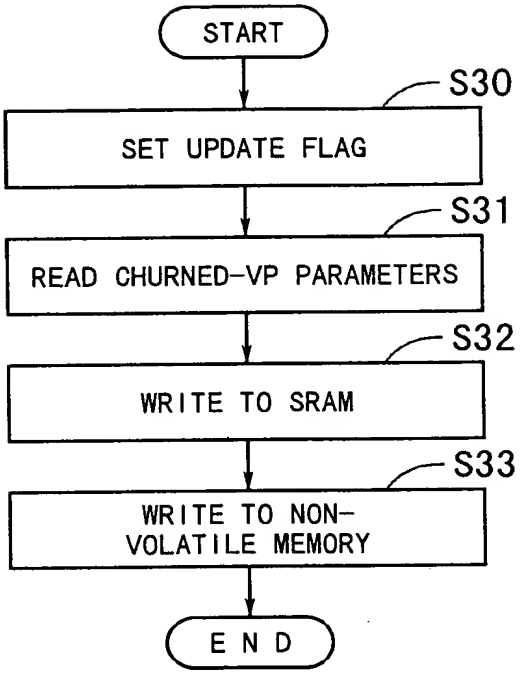

START
S30
SET UPDATE FLAG
S31
READ CHURNED-VP PARAMETERS
S32
WRITE TO SRAM
S33
WRITE TO NON-VOLATILE MEMORY
END

FIG. 9

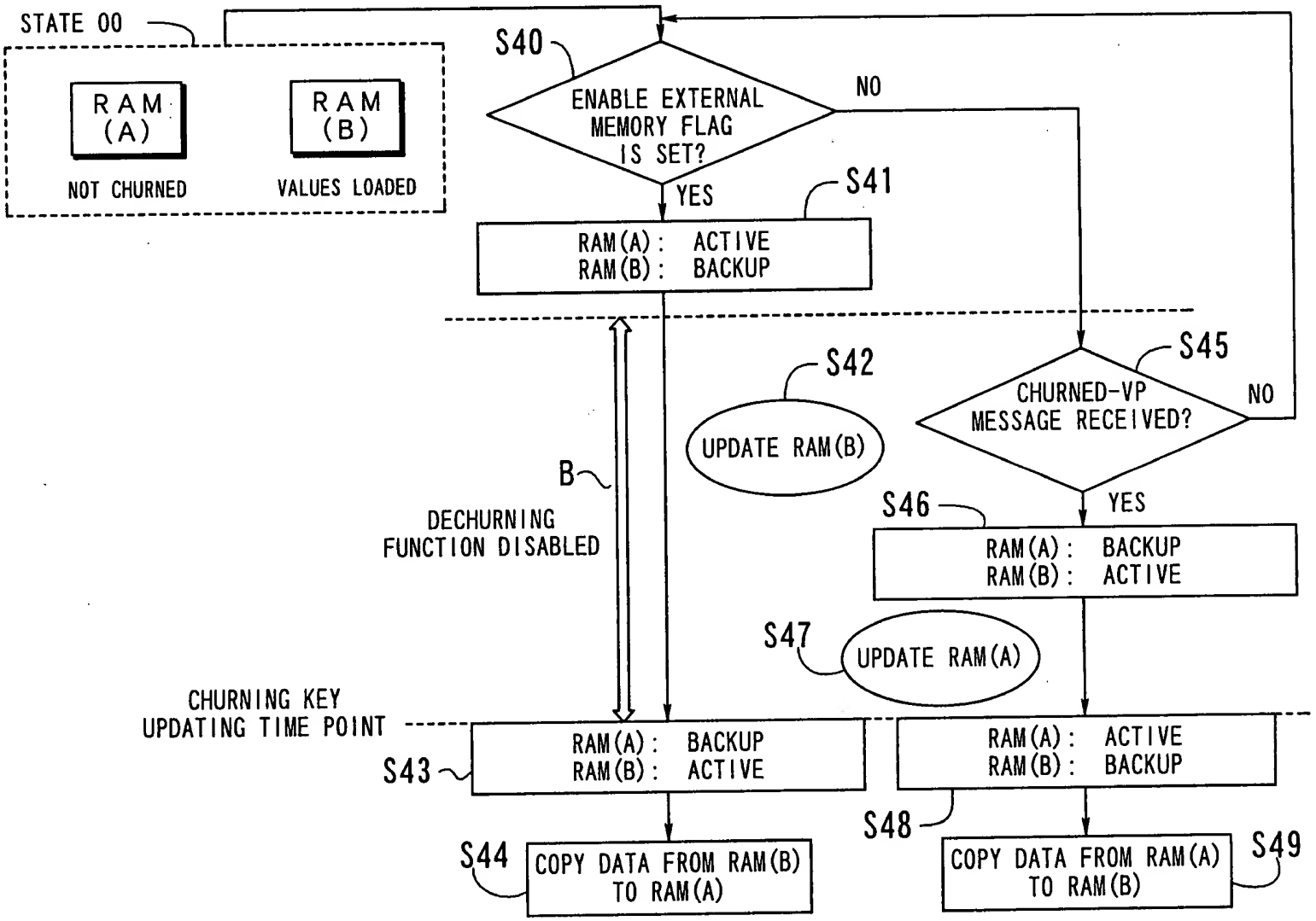

STATE 00
RAM (A)
NOT CHURNED
RAM (B)
VALUES LOADED
S40
ENABLE EXTERNAL MEMORY FLAG IS SET?
NO
YES
S41
RAM(A): ACTIVE
RAM(B): BACKUP
S42
UPDATE RAM(B)
S45
CHURNED-VP MESSAGE RECEIVED?
NO
YES
B
DECHURNING FUNCTION DISABLED
S46
RAM(A): BACKUP
RAM(B): ACTIVE
S47
UPDATE RAM(A)
CHURNING KEY UPDATING TIME POINT
S43
RAM(A): BACKUP
RAM(B): ACTIVE
RAM(A): ACTIVE
RAM(B): BACKUP
S48
S44
COPY DATA FROM RAM(B) TO RAM(A)
COPY DATA FROM RAM(A) TO RAM(B)
S49

FIG. 10

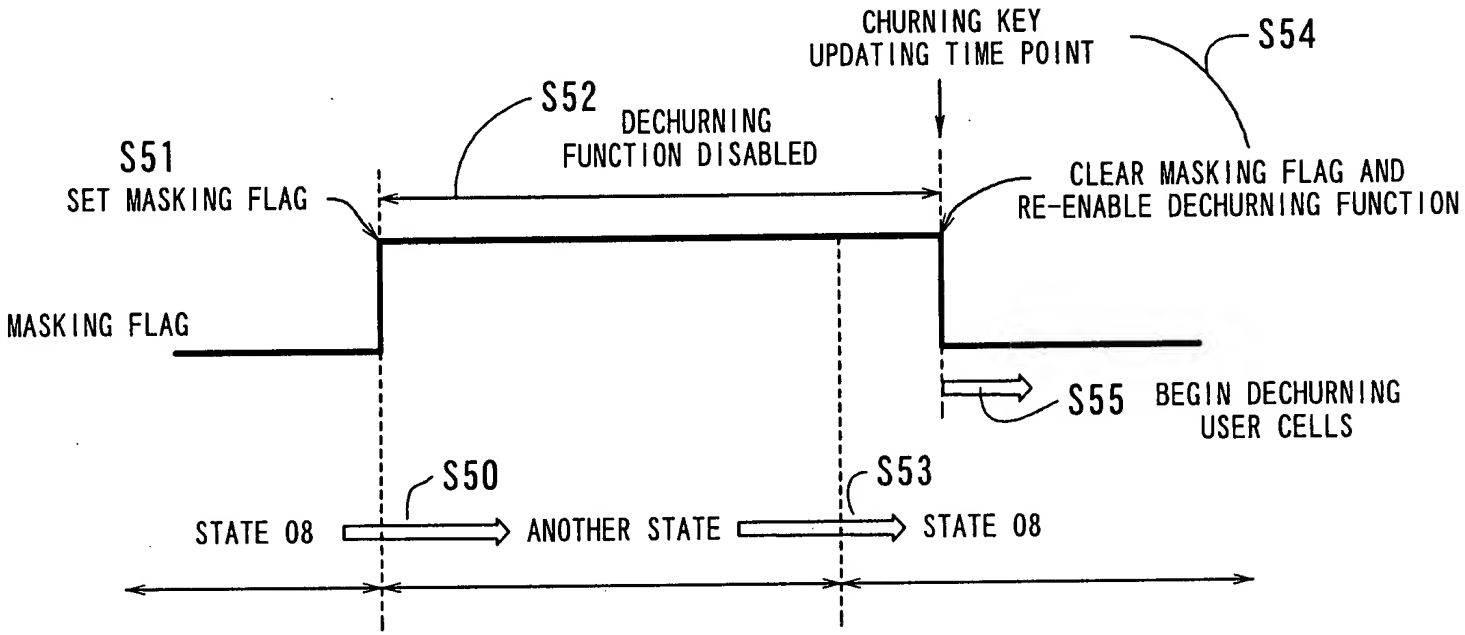

CHURNING KEY
UPDATING TIME POINT
S54
S52
DECHURNING
FUNCTION DISABLED
S51
SET MASKING FLAG
CLEAR MASKING FLAG AND
RE-ENABLE DECHURNING FUNCTION
MASKING FLAG
S55
BEGIN DECHURNING
USER CELLS
S50
S53
STATE 08
ANOTHER STATE
STATE 08

FIG. 11

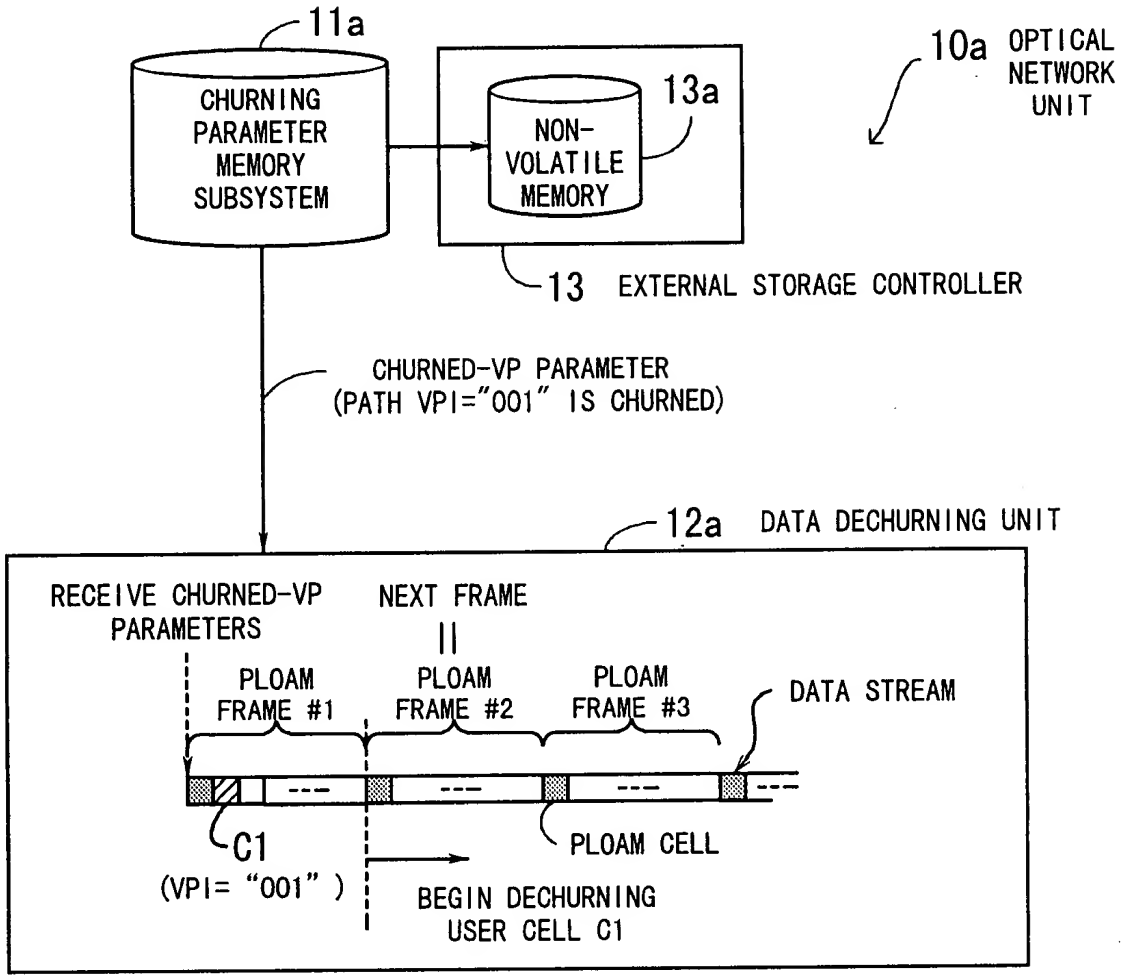

11a
CHURNING PARAMETER MEMORY SUBSYSTEM
13a
NON-VOLATILE MEMORY
10a OPTICAL NETWORK UNIT
13 EXTERNAL STORAGE CONTROLLER
CHURNED-VP PARAMETER
(PATH VPI="001" IS CHURNED)
12a DATA DECHURNING UNIT
RECEIVE CHURNED-VP PARAMETERS
NEXT FRAME
PLOAM FRAME #1
PLOAM FRAME #2
PLOAM FRAME #3
DATA STREAM
C1
(VPI= "001")
PLOAM CELL
BEGIN DECHURNING USER CELL C1

FIG. 12

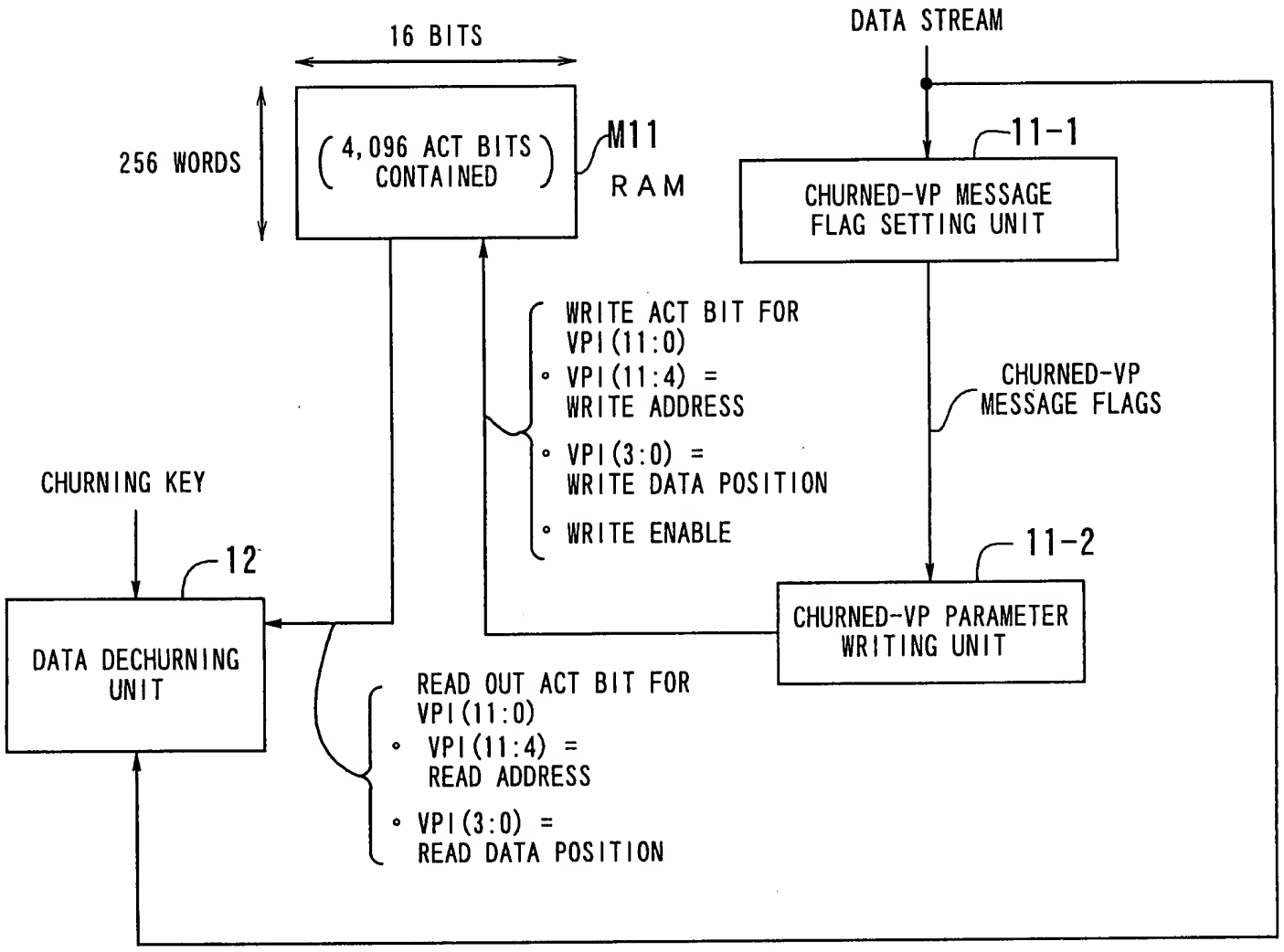
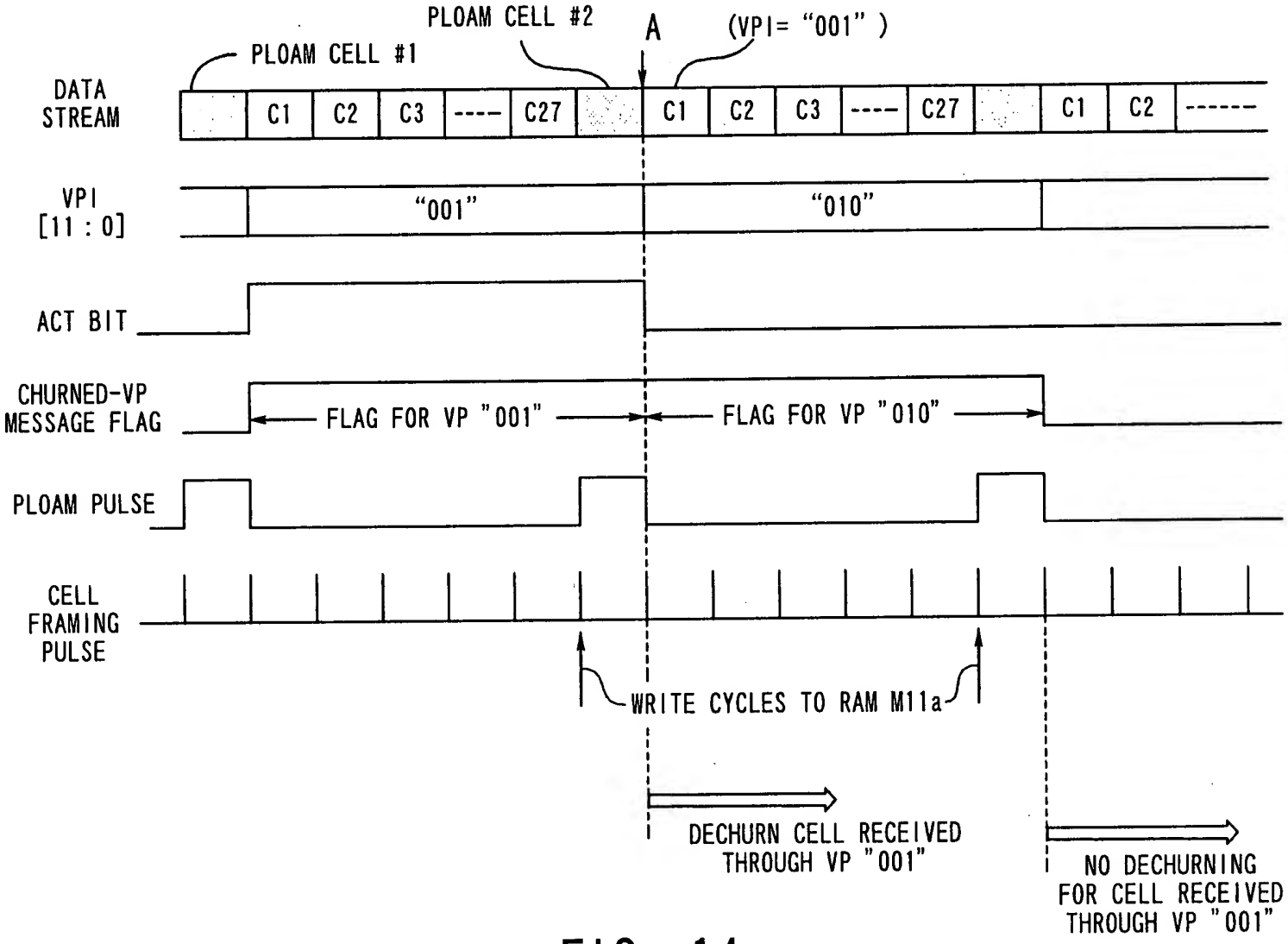

16 BITS
256 WORDS
(4,096 ACT BITS CONTAINED)
M11
RAM
DATA STREAM
11-1
CHURNED-VP MESSAGE FLAG SETTING UNIT
WRITE ACT BIT FOR VPI(11:0)
∘ VPI(11:4) = WRITE ADDRESS
∘ VPI(3:0) = WRITE DATA POSITION
∘ WRITE ENABLE
CHURNED-VP MESSAGE FLAGS
CHURNING KEY
12
11-2
DATA DECHURNING UNIT
CHURNED-VP PARAMETER WRITING UNIT
READ OUT ACT BIT FOR VPI(11:0)
∘ VPI(11:4) = READ ADDRESS
∘ VPI(3:0) = READ DATA POSITION

FIG. 13


PLOAM CELL #2
A
(VPI= "001")
PLOAM CELL #1
DATA STREAM
C1
C2
C3

C27
C1
C2
C3

C27
C1
C2

VPI [11 : 0]
"001"
"010"
ACT BIT
CHURNED-VP MESSAGE FLAG
FLAG FOR VP "001"
FLAG FOR VP "010"
PLOAM PULSE
CELL FRAMING PULSE
WRITE CYCLES TO RAM M11a
DECHURN CELL RECEIVED THROUGH VP "001"
NO DECHURNING FOR CELL RECEIVED THROUGH VP "001"

FIG. 14

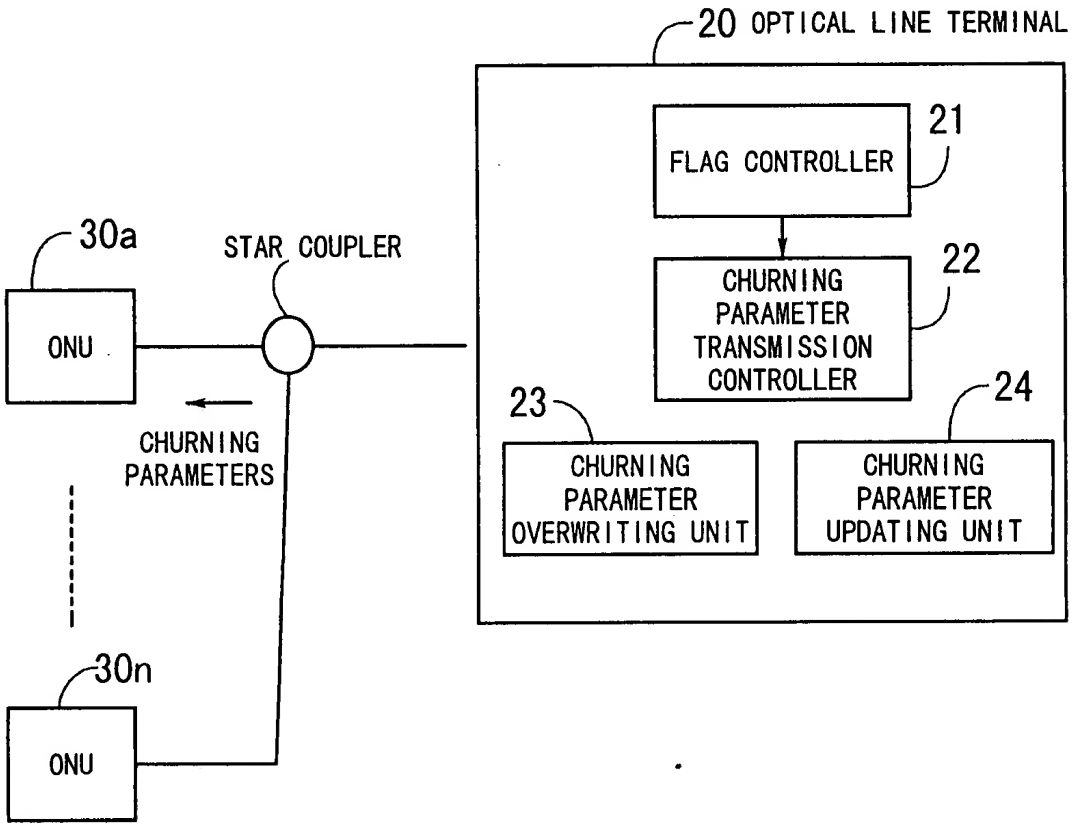

20 OPTICAL LINE TERMINAL
FLAG CONTROLLER
21
22
CHURNING PARAMETER TRANSMISSION CONTROLLER
23
CHURNING PARAMETER OVERWRITING UNIT
24
CHURNING PARAMETER UPDATING UNIT
30a
STAR COUPLER
ONU
CHURNING PARAMETERS
30n
ONU

FIG. 15

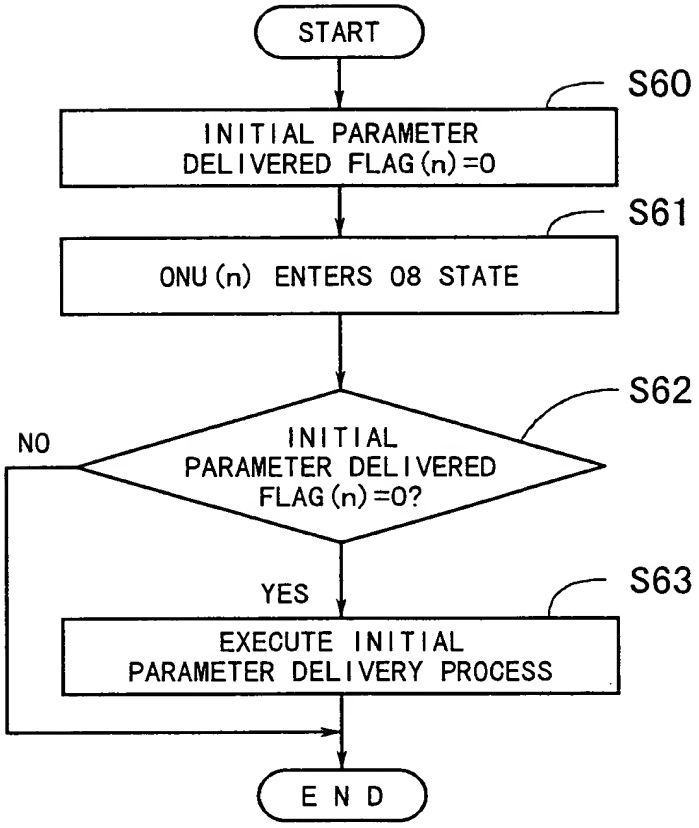

START
S60
INITIAL PARAMETER DELIVERED FLAG(n)=0
S61
ONU(n) ENTERS 08 STATE
S62
INITIAL PARAMETER DELIVERED FLAG(n)=0?
NO
YES
S63
EXECUTE INITIAL PARAMETER DELIVERY PROCESS
END

FIG. 16

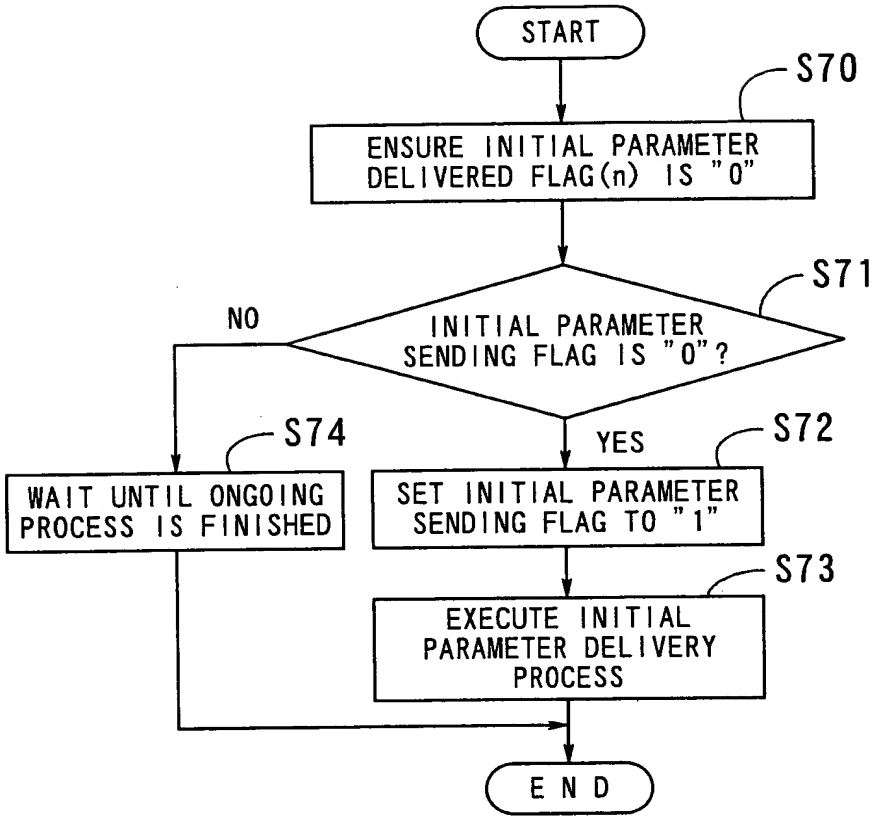

START
S70
ENSURE INITIAL PARAMETER DELIVERED FLAG(n) IS "0"
S71
INITIAL PARAMETER SENDING FLAG IS "0"?
NO
YES
S74
WAIT UNTIL ONGOING PROCESS IS FINISHED
S72
SET INITIAL PARAMETER SENDING FLAG TO "1"
S73
EXECUTE INITIAL PARAMETER DELIVERY PROCESS
END

FIG. 17

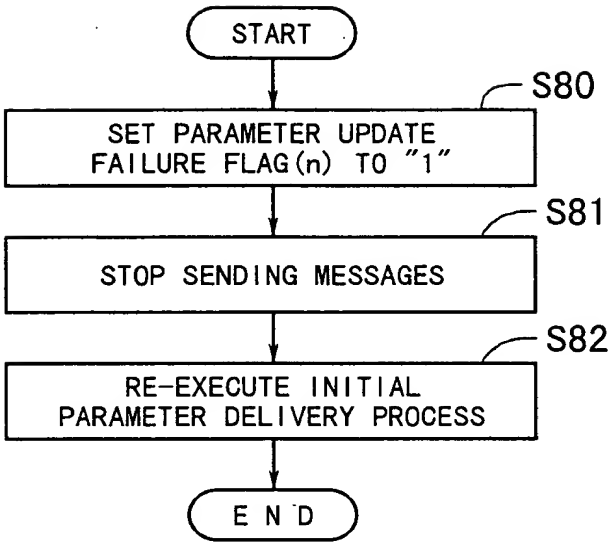

START
S80
SET PARAMETER UPDATE FAILURE FLAG(n) TO "1"
S81
STOP SENDING MESSAGES
S82
RE-EXECUTE INITIAL PARAMETER DELIVERY PROCESS
E N D

FIG. 18

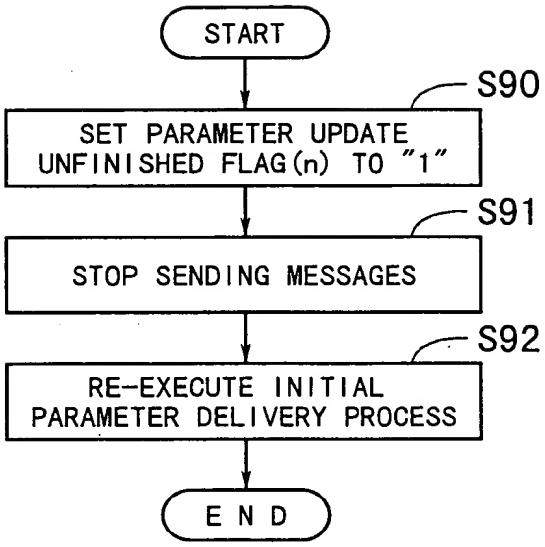

START
S90
SET PARAMETER UPDATE UNFINISHED FLAG(n) TO "1"
S91
STOP SENDING MESSAGES
S92
RE-EXECUTE INITIAL PARAMETER DELIVERY PROCESS
END

FIG. 19

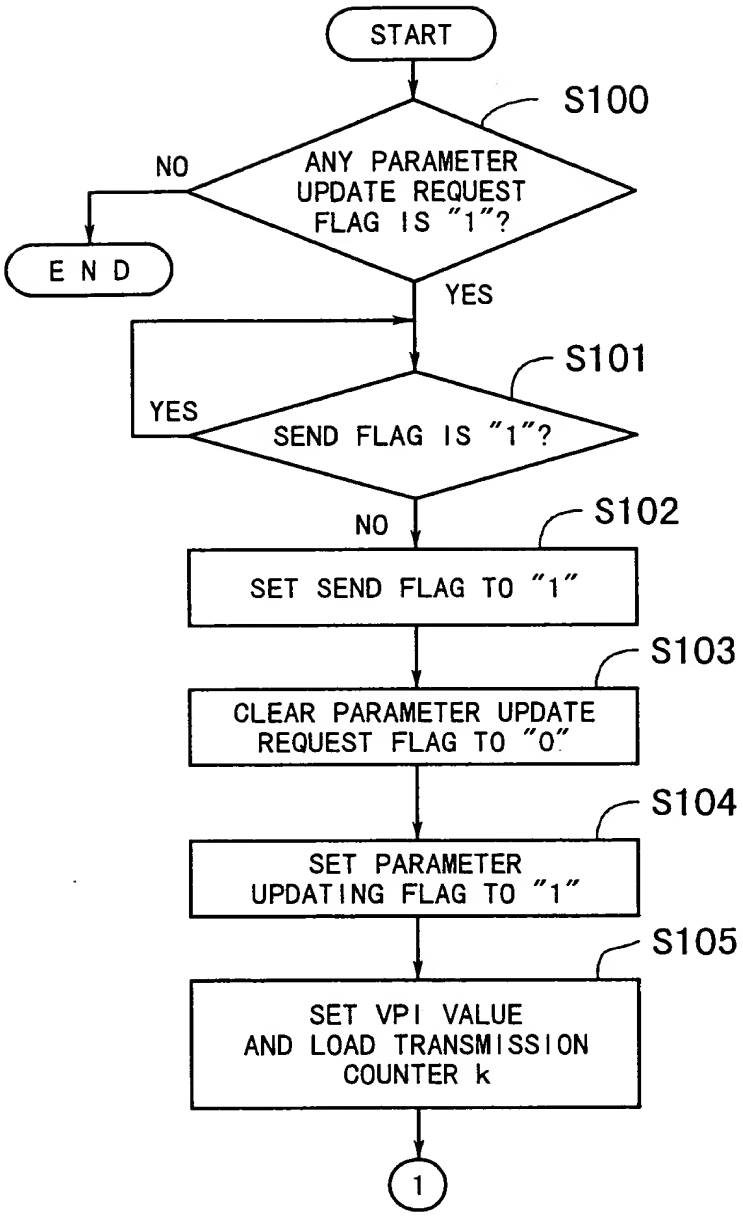

START
S100
ANY PARAMETER UPDATE REQUEST FLAG IS "1"?
NO
END
YES
S101
YES
SEND FLAG IS "1"?
NO
S102
SET SEND FLAG TO "1"
S103
CLEAR PARAMETER UPDATE REQUEST FLAG TO "0"
S104
SET PARAMETER UPDATING FLAG TO "1"
S105
SET VPI VALUE AND LOAD TRANSMISSION COUNTER k
1

FIG. 20

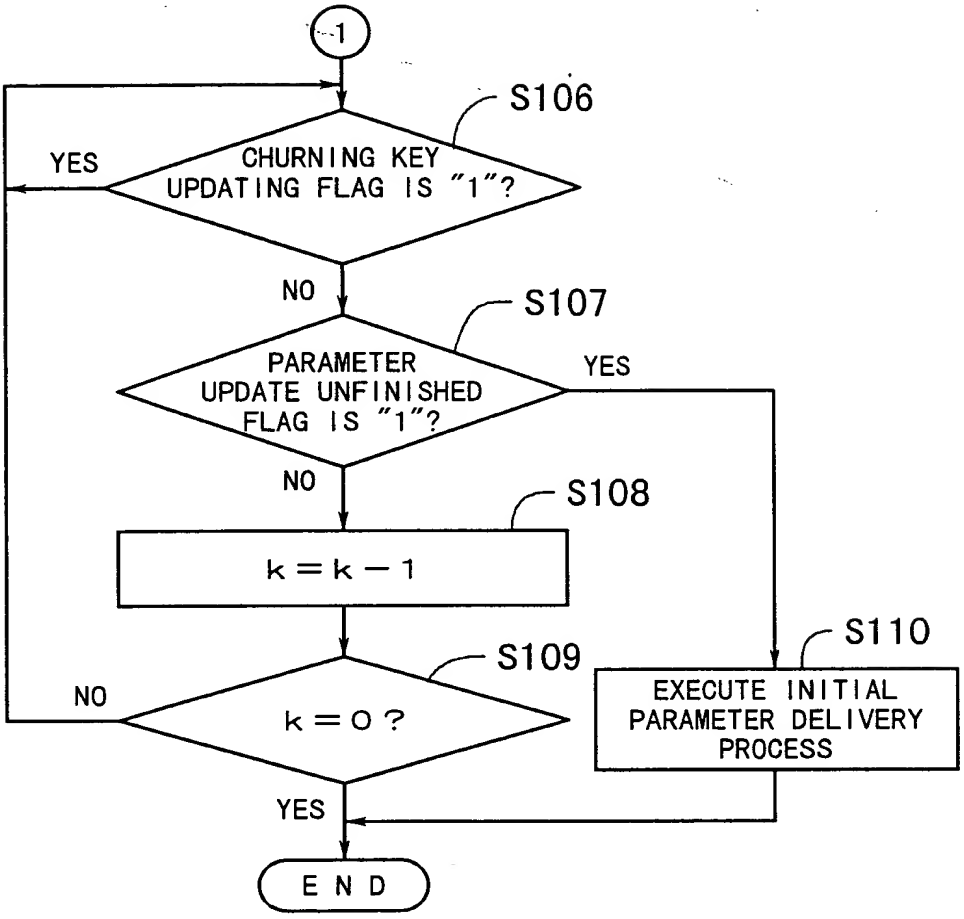

1
S106
CHURNING KEY UPDATING FLAG IS "1"?
YES
NO
S107
PARAMETER UPDATE UNFINISHED FLAG IS "1"?
YES
NO
S108
k = k − 1
S109
k = 0 ?
NO
YES
S110
EXECUTE INITIAL PARAMETER DELIVERY PROCESS
E N D

FIG. 21

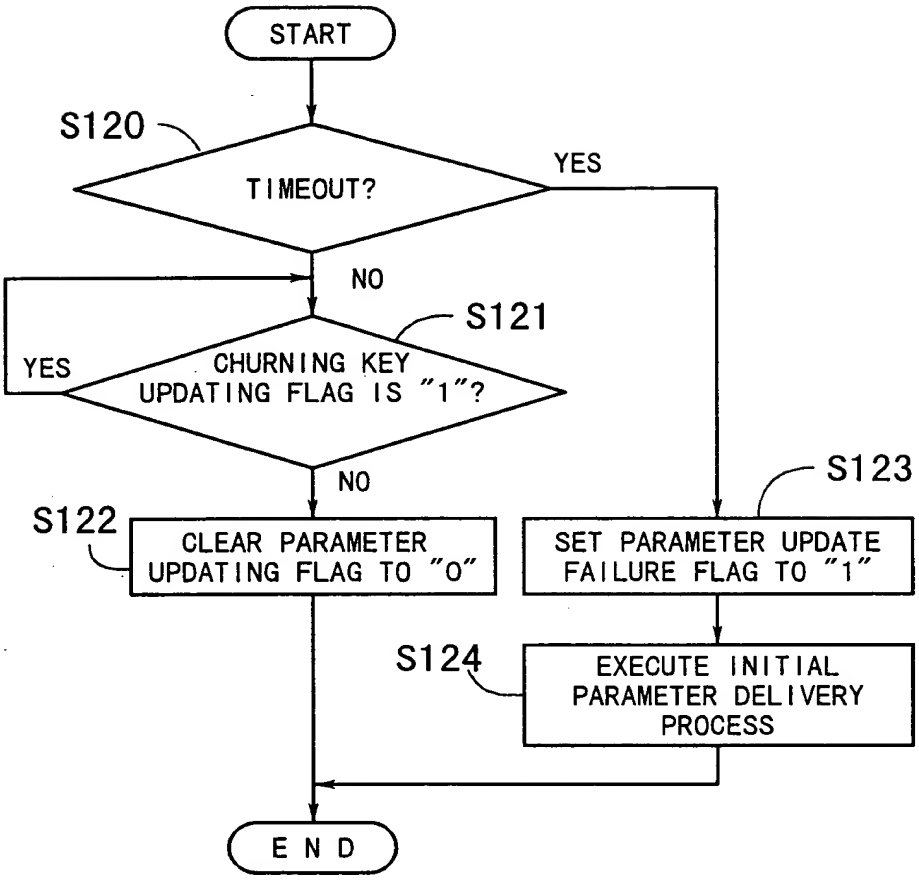

START
S120
TIMEOUT?
YES
NO
S121
YES
CHURNING KEY UPDATING FLAG IS "1"?
NO
S123
S122
CLEAR PARAMETER UPDATING FLAG TO "0"
SET PARAMETER UPDATE FAILURE FLAG TO "1"
S124
EXECUTE INITIAL PARAMETER DELIVERY PROCESS
END

FIG. 22

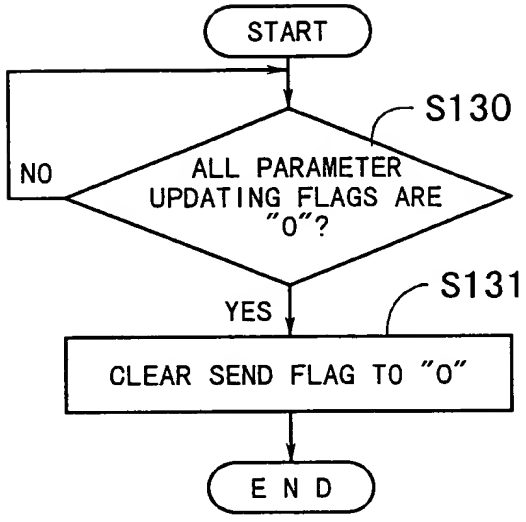

START
S130
NO
ALL PARAMETER UPDATING FLAGS ARE "0"?
YES
S131
CLEAR SEND FLAG TO "0"
E N D

FIG. 23

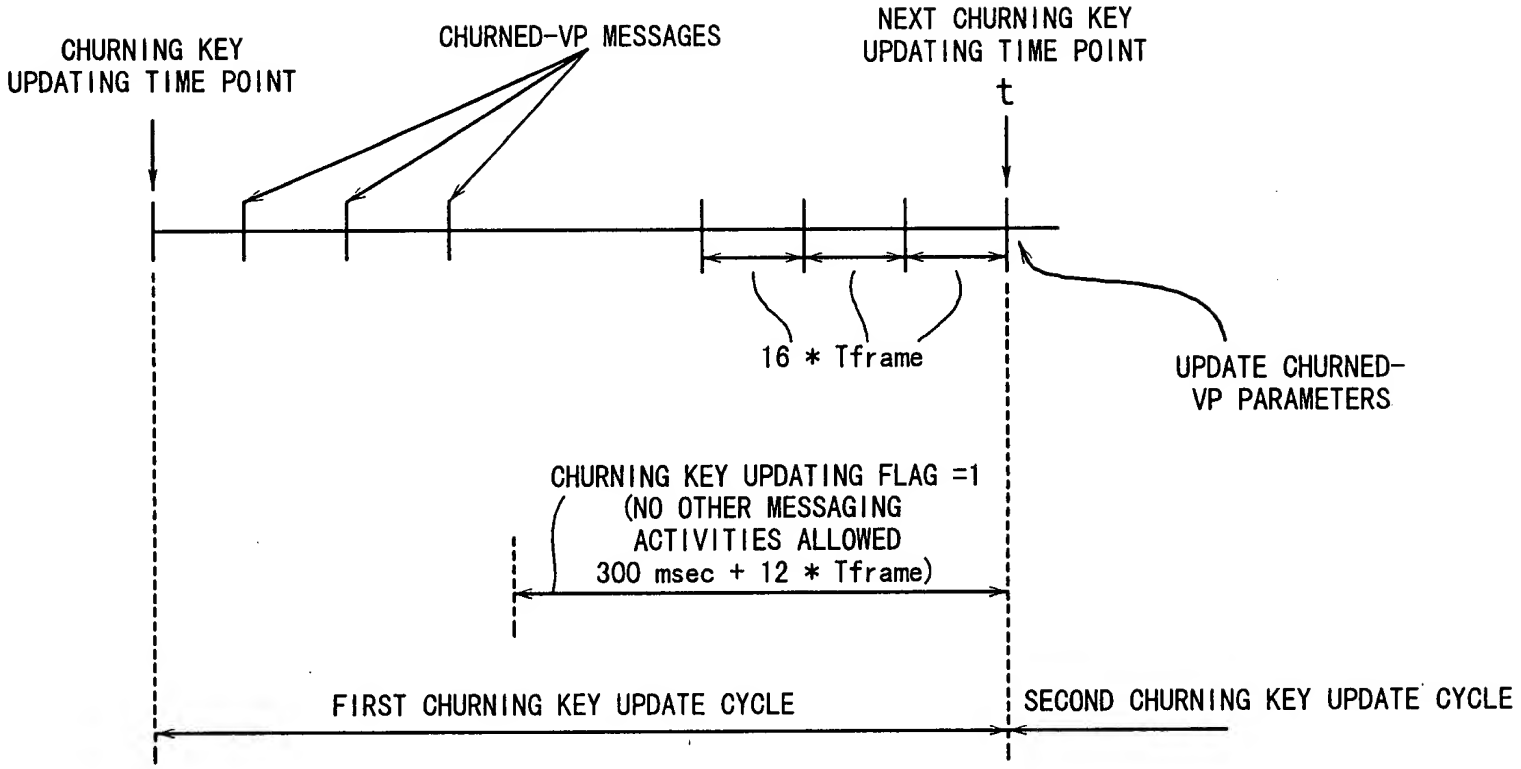
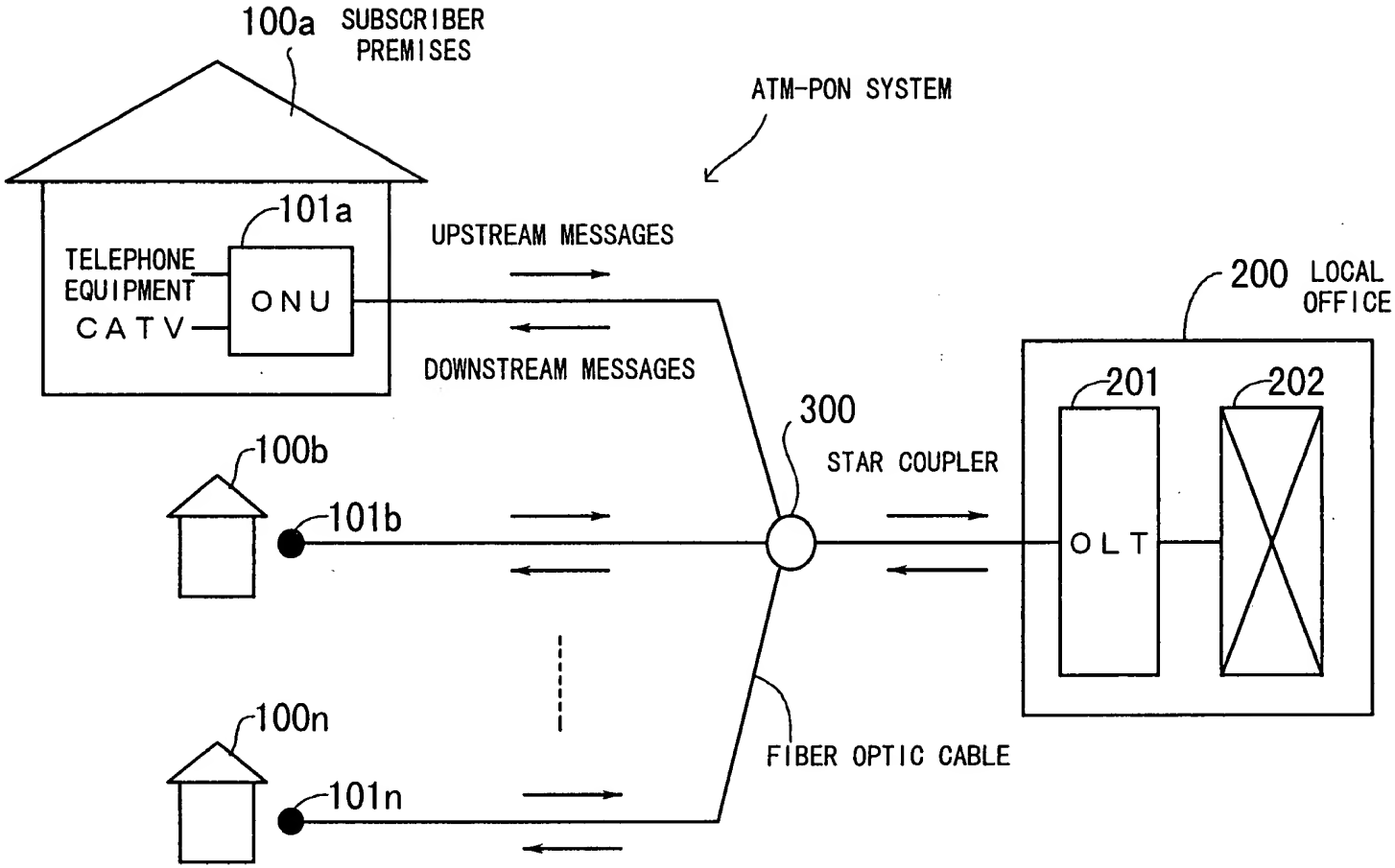

CHURNING KEY
UPDATING TIME POINT
CHURNED-VP MESSAGES
NEXT CHURNING KEY
UPDATING TIME POINT
t
16 * Tframe
UPDATE CHURNED-
VP PARAMETERS
CHURNING KEY UPDATING FLAG =1
(NO OTHER MESSAGING
ACTIVITIES ALLOWED
300 msec + 12 * Tframe)
FIRST CHURNING KEY UPDATE CYCLE
SECOND CHURNING KEY UPDATE CYCLE

FIG. 24



PRIOR ART

FIG. 25